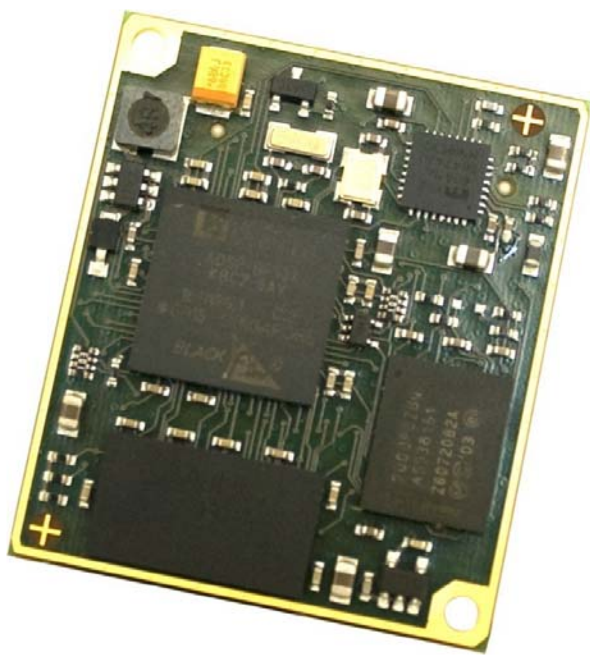
Hardware User Manual



CM-BF537E V3.0

Tinyboards from Bluetechnix
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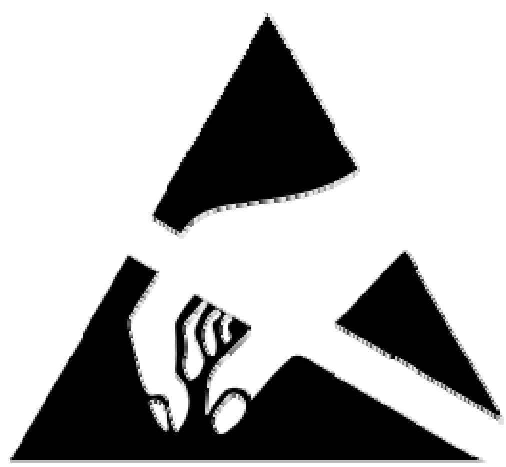
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Warnings
Due to technical requirements components may contain dangerous substances.

The Core Modules and development systems contain ESD (electrostatic discharge) sensitive devices. Electrostatic charges readily accumulate on the human body and equipment and can discharge without detection. Permanent damage may occur on devices subjected to high-energy discharges. Proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Unused Core Modules and Development Boards should be stored in the protective shipping package.



BLACKFIN Products

Core Modules:

CM-BF533:	Blackfin Processor Module powered by Analog Devices' single core ADSP-BF533 processor; up to 600MHz, 32MB SDRAM, 2MB flash, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
CM-BF537E:	Blackfin Processor Module powered by Analog Devices' single core ADSP-BF537 processor; up to 600MHz, 32MB SDRAM, 4MB flash, integrated TP10/100 Ethernet physical transceiver, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
CM-BF537U:	Blackfin Processor Module powered by Analog Devices' single core ADSP-BF537 processor; up to 600MHz, 32MB SDRAM, 4MB flash, integrated USB 2.0 Device, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
TCM-BF537:	Blackfin Processor Module powered by Analog Devices' single core ADSP-BF537 processor; up to 500MHz, 32MB SDRAM, 8MB flash, a size of 28x28mm, 2x60 pin expansion connectors, Ball Grid Array or Border Pads for reflow soldering, industrial temperature range -40°C to +85°C.
CM-BF561:	Blackfin Processor Module powered by Analog Devices' dual core ADSP-BF561 processor; up to 2x 600MHz, 64MB SDRAM, 8MB flash, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
CM-BF527:	The new Blackfin Processor Module is powered by Analog Devices' single core ADSP-BF527 processor; key features are USB OTG 2.0 and Ethernet. The 2x60 pin expansion connectors are backwards compatible with other Core Modules.
CM-BF548:	The new Blackfin Processor Module is powered by Analog Devices' single core ADSP-BF548 processor; key features are 64MB DDR SD-RAM 2x100 pin expansion connectors.
TCM-BF518:	The new Core Module CM-BF518 is powered by Analog Devices' single core ADSP-BF518 processor; up to 400MHz, 32MB SDRAM, up to 8MB flash. The 2x60 pin expansion connectors are backwards compatible with other Core Modules.

Development Boards:

EVAL-BF5xx:	Low cost Blackfin processor Evaluation Board with one socket for any Bluetechnix Blackfin Core Module. Additional interfaces are available, e.g. an SD-Card.

DEV-BF5xxDA-Lite: Get ready to program and debug Bluetechnix Core Modules with this tiny development platform including an USB-Based Debug Agent. The DEV-BF5xxDA-Lite is a low cost starter development system including a VDSP++ Evaluation Software License.

DEV-BF548-Lite: Low-cost development board with one socket for Bluetechnix CM-BF548 Core Module. Additional interfaces are available, e.g. an SD-Card, USB and Ethernet.

DEV-BF548DA-Lite: Get ready to program and debug Bluetechnix CM-BF548 Core Module with this tiny development platform including an USB-Based Debug Agent. The DEV-BF548DA-Lite is a low-cost starter development system including a VDSP++ Evaluation Software License.

EXT-Boards: The following Extender Boards are available: EXT-BF5xx-AUDIO, EXT-BF5xx-VIDEO, EXT-BF5xx-CAM, EXT-BF5xx-EXP-TR, EXT-BF5xx-USB-ETH2, EXT-BF5xx-AD/DA, EXT-BF548-EXP and EXT-BF518-ETH. Furthermore, we offer the development of customized extender boards for our customers.

Software Support:

BLACKSheep: The BLACKSheep VDK is a multithreaded framework for the Blackfin processor family from Analog Devices that includes driver support for a variety of hardware extensions. It is based on the real-time VDK kernel included within the VDSP++ development environment.

LabVIEW: LabVIEW embedded support for Bluetechnix Core Modules is done by Schmid-Engineering AG: http://www.schmid-engineering.ch

uClinux: All the Core Modules are fully supported by uClinux. The required boot loader and uClinux can be downloaded from: http://blackfin.uClinux.org.

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BLACKFIN Design Service

Based on more than five years of experience with Blackfin, Bluetechnix offers development assistance as well as custom design services and software development.

1 Introduction

The CM-BF537E is a tiny, high performance and low power DSP/RISC Core Module incorporating Analog Devices Blackfin family of processors. The special feature of this module is the on-board 10/100Mbit Ethernet interface which includes the physical transceiver chip. The module allows easy integration into high demanding very space and power limited applications.

1.1 Overview

The Core Module CM-BF537E consists of the following components:

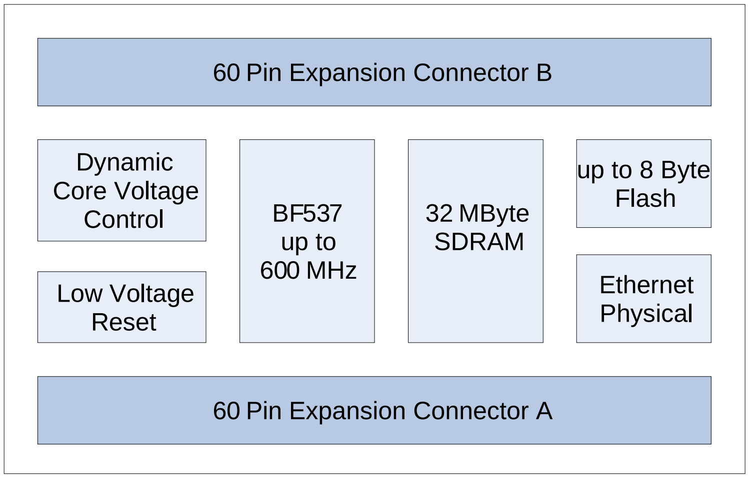


Figure 1-1: Main components of the CM-BF537E Core Module

- **Analog Devices Blackfin Processor BF537**
    - Supported Chips :
        - ADSP-BF537SBBCZ-5A (-40°-85°C) Option upon request
        - ADSP-BF537SKBCZ-6A (0°-70°C) Standard Mount
- **32 MB SDRAM**
    - SDRAM Clock up to 133MHz
    - MT48LC16M16A2BG-7 (16Mx16, 256Mbit at 3.3 V)
- **4 MB of Addressable Flash**
    - PF48F2000P0ZBQ0 (4Mx16 32Mbit at 3.3 V; default only 4 MByte addressable)
    - Additional flash memory can be connected through the expansion board as parallel flash using asynchronous chip select lines or as an SPI flash.

- **Low Voltage Reset Circuit**
  - Resets module if power supply goes below 2.93 V for at least 140 ms
- **Dynamic Core Voltage Control**
  - Core voltage is adjustable by setting software registers on the Blackfin processor
  - Core voltage range: 0.8 – 1.32V
- **Expansion Connector A**
  - Data Bus
  - Address Bus
  - Control Signals
  - Power Supply
  - Ethernet Pins
- **Expansion Connector B**
  - SPORT0
  - JTAG
  - UART0/UART1
  - CAN
  - TWI (I2C compatible)
  - SPI
  - PPI (Parallel Port Interface)
  - GPIO’s

1.2 Key Features

- The CM-BF537E is very compact and measures only 36.5x31.5mm
- Allows quick prototyping of product that comes very close to the final design
- Reduces development costs, faster time to market
- Very cost effective for small and medium volumes

1.3 Target Applications

- Generic high performance signal processor module
- Internet Connected Embedded System
- High performance web camera
- Robotics: Tiny processor module for mobile robots

2 Specification

2.1 Functional Specification

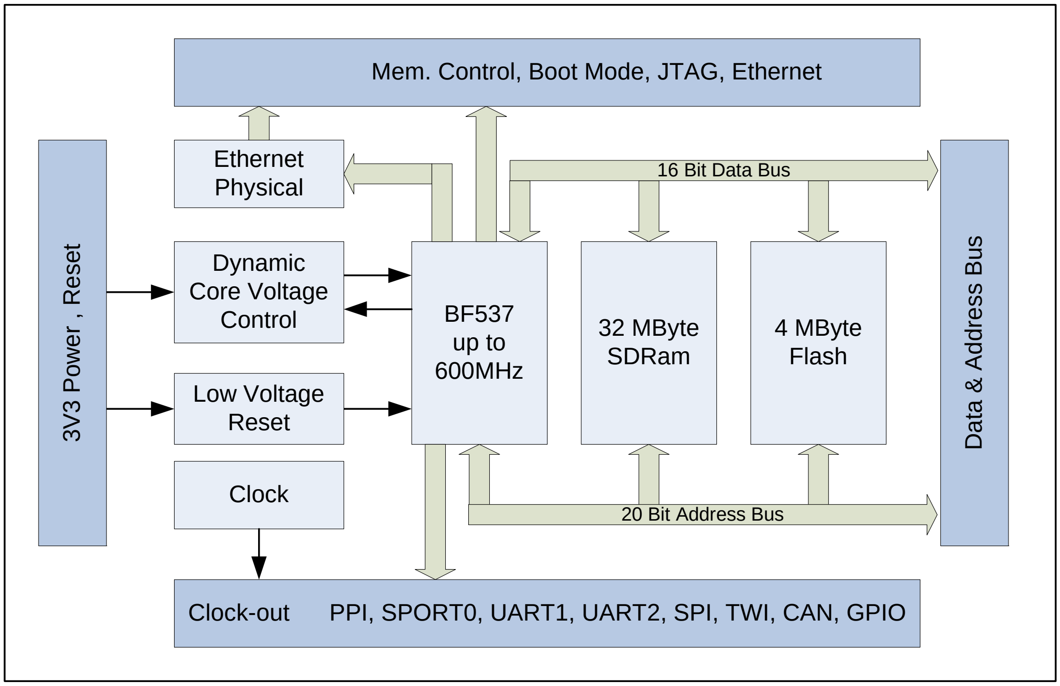


Figure 2-1: Detailed Block Diagram

Figure 2-1 shows a detailed block diagram of the CM-BF537E module. Other than the SDRAM control pins the CM-BF537E has all other pins of the Blackfin processor on its two main 60 pin connectors.

A special feature of the CM-BF537E Core Module is the on-board physical Ethernet transceiver from Micrel (KSZ8041BL).

Dynamic voltage control allows reducing power consumption to a minimum adjusting the core voltage and the clock frequency dynamically in accordance to the required processing power. A low voltage reset circuit guarantees a power on reset and resets the system when the input voltage drops below 2.93V.

2.2 Boot Mode

By default the boot mode = 000 (BMODE2 = low, BMODE1 = low, BMODE0 = low). All BMODE pins have internal pull down resistors.
Connect BMODE0 to Vcc and leave BMODE1, BMODE2 pins open for boot mode 001 equals to 8 or 16 bit PROM/FLASH boot mode, this is the default boot mode of the Blacksheep software. See Blackfin Datasheets or Eval/DevBoard manuals for more details.

2.3 Memory MAP

Memory Type	Start Address	End Address	Size	Comment
FLASH Bank0 (PF4 Flag **low**)	0x20000000	0x201FFFFF	2MB	4MB Micron Flash, PF48F2000P0ZBQ0
FLASH Bank1 (PF4 Flag **high**)	0x20000000	0x201FFFFF	2MB	
SD-RAM	0x00000000	0x01FFFFFF	32MB	16Bit Bus, Micron MT48LC16M16A2FG

Table 2-1: Memory Map

The maximum amount of memory addressable by a single asynchronous memory bank, of the Blackfin processor is 2MB. In order to be able to use more than 2MB on a single bank, 2 GPIOs are used to select which 2MB section of flash is visible in the memory window of the Blackfin processor. This frees up the remaining banks for the user.

2.4 Electrical Specification

2.4.1 Supply Voltage

- 3.3V DC +/-10%

2.4.2 Supply Voltage Ripple

- 100mV peak to peak 0-20 MHz

2.4.3 Input Clock Frequency

- 25 MHz

The Blackfin Processor Input Clock frequency is 25MHz, this frequency is derived from the on-board crystal/oscillator and drives the Blackfin Processors's Clock generator. This frequency is also provided on the connector as pin 78 (CLK_out).

2.4.4 Real Time Clock Crystal

- 32.768kHz

2.4.5 Supply Current

- Maximum current: 350mA @ 3.3V
- Typical operating conditions:
  - Processor running at 600MHz, Core Voltage 1.2V, SDRAM 20% bandwidth utilization at 130MHz; Ethernet idle: 200mA @ 3.3V
  - Processor running at 300MHz, Core Voltage 0.8V SDRAM 20% bandwidth utilization at 130MHz; Ethernet idle: 140mA @ 3.3V
  - Processor running at 600MHz, Core Voltage 1.2V, SDRAM 20% bandwidth utilization at 130MHz, Ethernet TX/RX active: 250mA

2.5 Environmental Specification

2.5.1 Temperature

- Operating at full 600MHz: 0 to + 70° C

2.5.2 Humidity

Operating: 10% to 90% (non condensing)

3 CM-BF537E (Connector Version)

3.1 Mechanical Outline

TOP VIEW
All dimensions are given in millimeters!

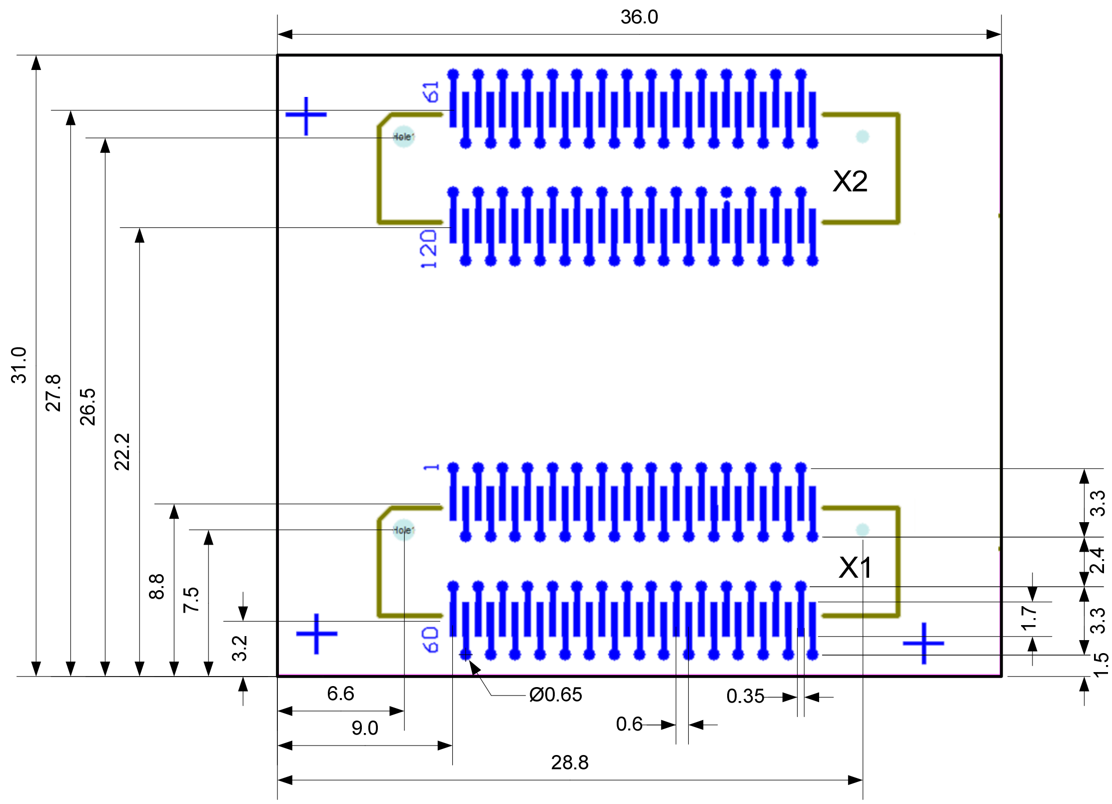


Figure 3-1: Mechanical outline and Bottom Connectors (Top View)

The mechanical outline represents a top view of the connectors placed at the bottom of the core board.

The module is shipped with two 60pin connectors.

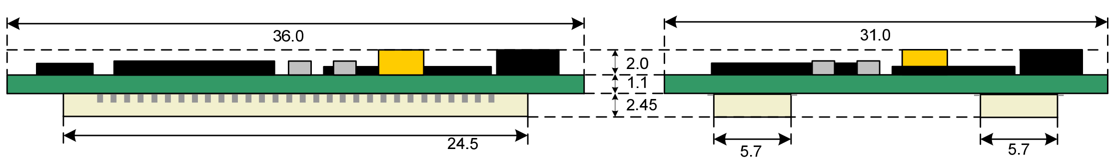


Figure 3-2: Side view with Connector mounted

The total minimum mounting height including receptacle at the motherboard is 6.1mm.

3.2 Footprint - Connector Version

If the connector version (2x Hirose 0.6mm pitch) is used, the footprint for the baseboard may look as shown in Figure 3-3.

For the baseboard the following connectors have to be used:

Part Baseboard	Manufacturer	Manufacturer Part No.
X1,X2	Hirose	FX8-60S-SV

Table 3-1: Baseboard connector types

The Connectors on the CM-BF537E are of the following type:

Part	Manufacturer	Manufacturer Part No.
X1,X2	Hirose 3mm height	FX8-60P-SV

Table 3-2: Module connector types

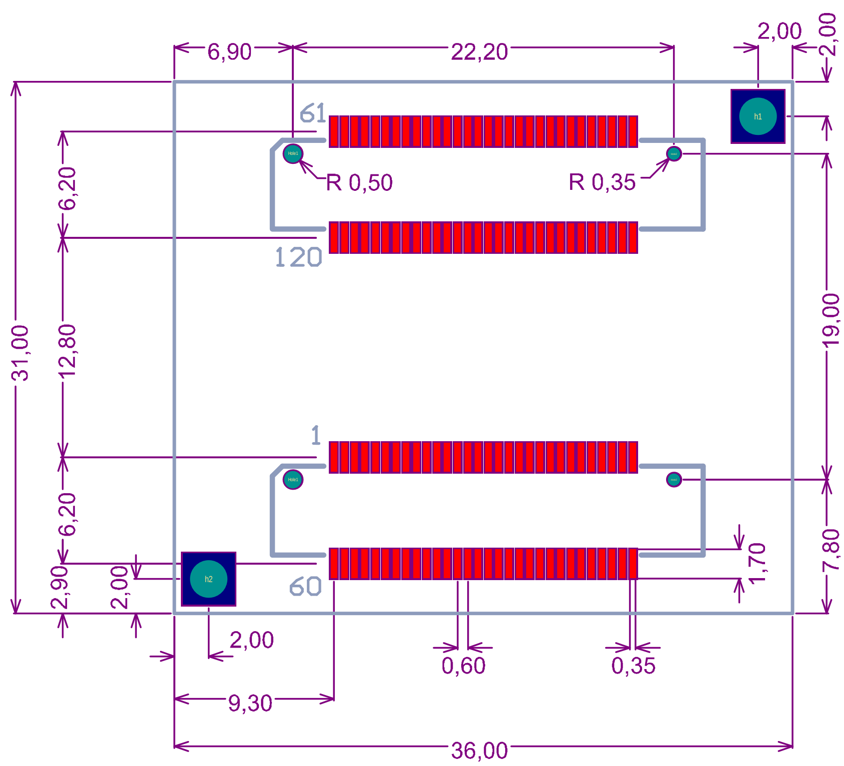


Figure 3-3: Recommended footprint for the Core Module (top view)

3.3 Mount Options

The mount options of the Core Module are shown in Figure 3-4.

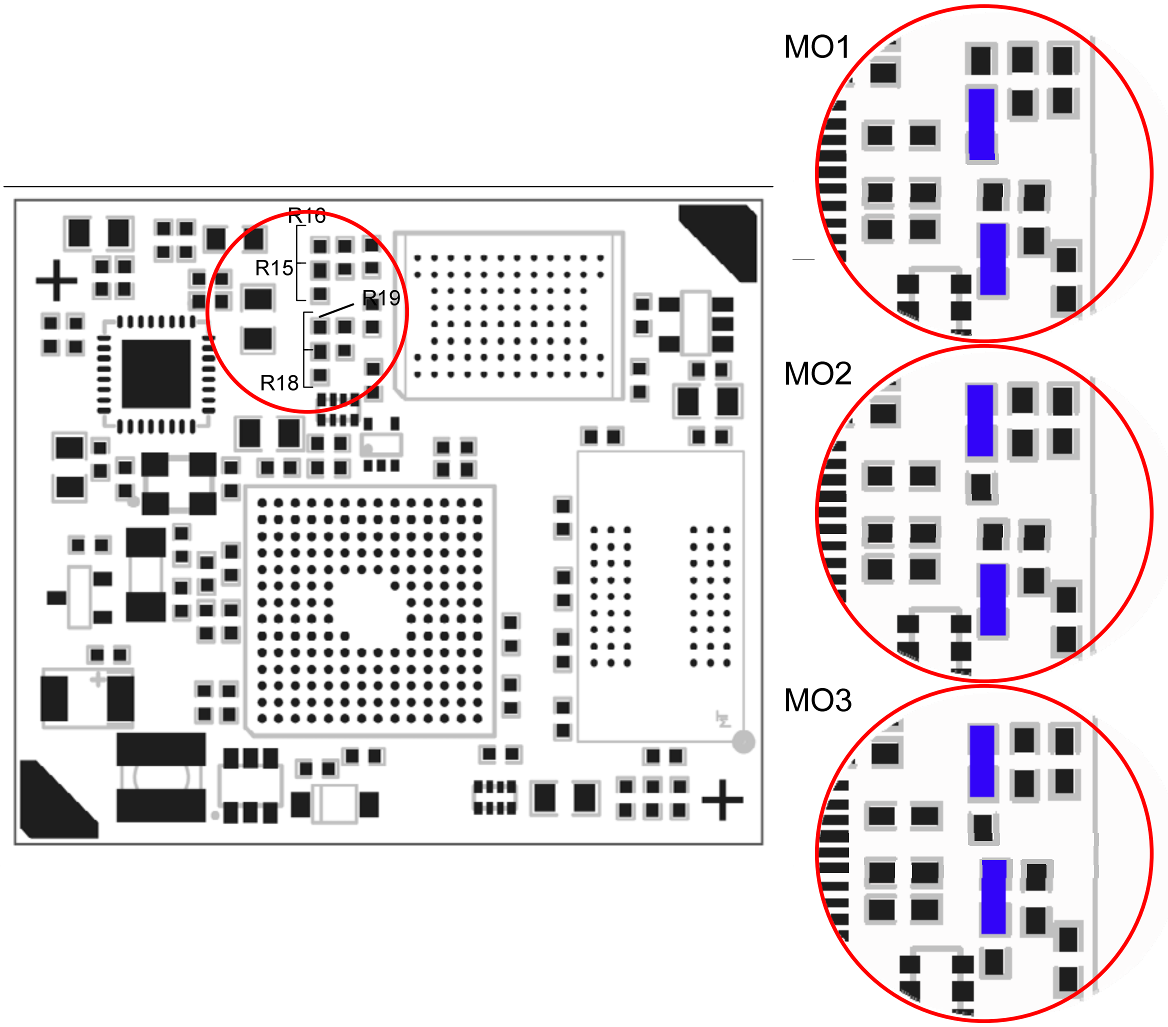


Figure 3-4: Core Module (component side)

Mount Option	Flash	Comment
MO1	2MB	PF4 available on pin 7 on connector X1
MO2	4MB	default
MO3	8MB	PF5 not available on connector X1

Table 3-3 Mount Options

3.4 Schematic Symbol (Signals of X1 and X2)

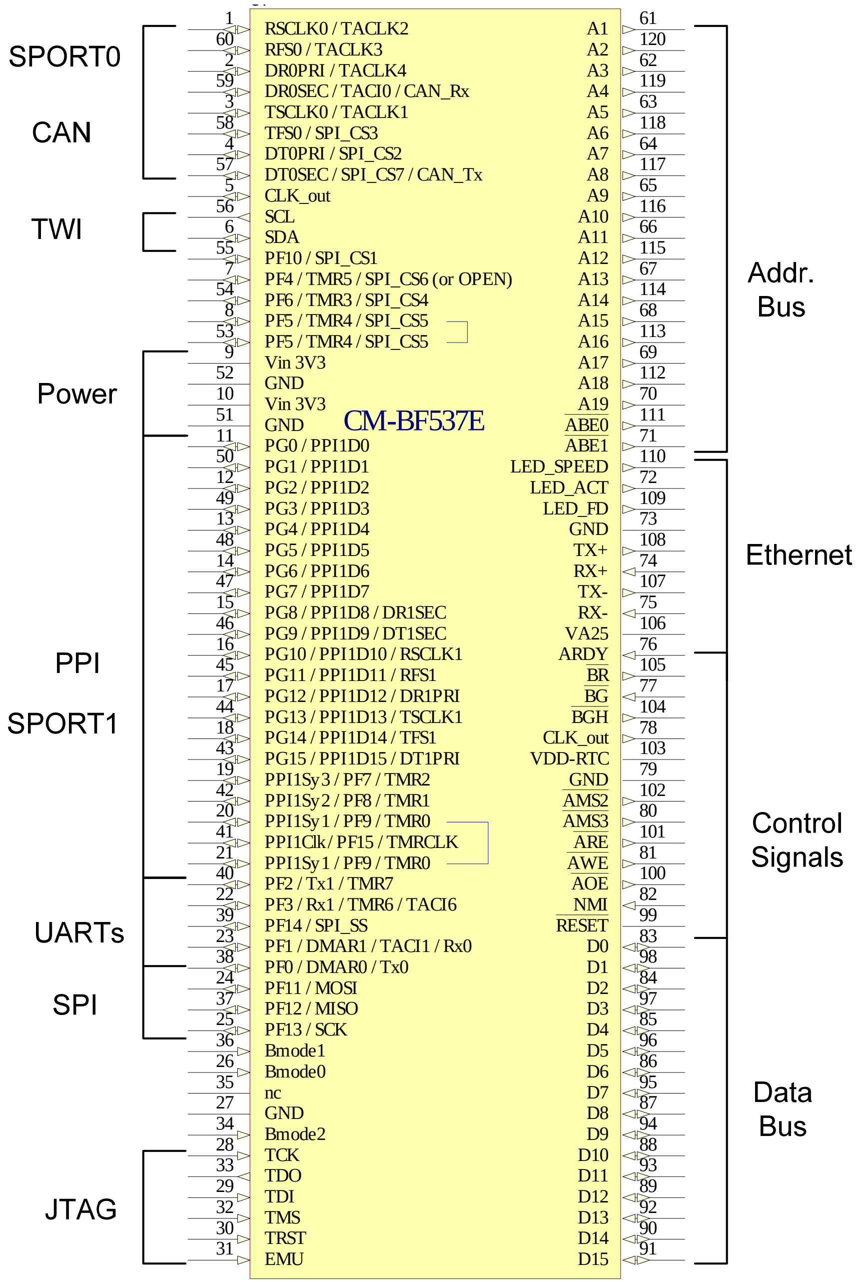


Figure 3-5: Schematic Symbol of Module

Note: For compatibility, 3 pins appear twice at the connector: CLK_out, PF5 and PPISy1

3.5 Connectors Pin Assignment

3.5.1 Connector X1 – (1-60)

Pin No.	Signal	IO Type
1	RSCLK0 / TACLK2	I/O
2	DR0PRI / TACLK4	I
3	TSCLK0 / TACLK1	I/O
4	DT0PRI / SSEL2	O
5	CLK_out	O
6	SDA	I/O
7	PF4 / TMR5 / SSEL6: MO1* nc: MO2, MO3*	I/O
8	PF5 / TMR4 / SSEL5: MO1, MO2* nc: MO3*	I/O
9	Vin 3V3	PWR
10	Vin 3V3	PWR
11	PG0 / PPI1D0	I/O
12	PG2 / PPI1D2	I/O
13	PG4 / PPI1D4	I/O
14	PG6 / PPI1D6	I/O
15	PG8 / PPI1D8 / DR1SEC	I/O
16	PG10 / PPI1D10 / RSCLK1	I/O
17	PG12 / PPI1D12 / DR1PRI	I/O
18	PG14 / PPI1D14 / TFS1	I/O
19	PPI1SY3 / PF7 / TMR2	I/O
20	PPI1SY1 / PF9 / TMR0	I/O
21	PPI1SY1 / PF9 / TMR0	I/O
22	PF3 / Rx1 / TMR6 / TACI6	I/O
23	PF1 / DMAR1 / TACI1 / Rx0	I/O
24	PF11 / MOSI	I/O
25	PF13 / SCK	I/O
26	BMODE0	I - 10k pull down
27	GND	PWR
28	TCK	I - 10k pull up
29	TDI	I - 10k pull up
30	$\overline{TRST}$	I - 4k7 pull down
31	$\overline{EMU}$	O
32	TMS	I - 10k pull up
33	TDO	O
34	BMODE2	I - 10k pull down
35	N.C.	-
36	BMODE1	I - 10k pull down
37	PF12 / MISO	I/O
38	PF0 / DMAR0 / Tx0	I/O
39	PF14 / SPI_SS	I/O
40	PF2 / Tx1 / TMR7	I/O

41	PPI1Clk / PF15 / TMRCLK	I/O
42	PPI1Sy2 / PF8 / TMR1	I/O
43	PG15 / PPI1D15 / DT1PRI	I/O
44	PG13 / PPI1D13 / TSCLK1	I/O
45	PG11 / PPI1D11 / RFS1	I/O
46	PG9 / PPI1D9 / DT1SEC	I/O
47	PG7 / PPI1D7	I/O
48	PG5 / PPI1D5	I/O
49	PG3 / PPI1D3	I/O
50	PG1 / PPI1D1	I/O
51	GND	PWR
52	GND	PWR
53	PF5 / TMR4 / SSEL5	I/O
54	PF6 / TMR3 / SSEL4	I/O
55	PF10 / SSEL1	I/O
56	SCL	I/O
57	DT0SEC / SSEL7 / CANTx	O
58	TFS0 / SSEL3	I/O
59	DR0SEC / TACI0 /	I
60	RFS0 / TACLK3	I/O

Table 3-4: Connector X1 pin assignment

* For mount option details see chapter 3.3.

Note 1: Pin 8 and 53 as well as pin 20 and 21 are identical.
Note 2: Please mind the mounted pull up and pull down resistors on the Core Module. See the third column of Table 3-4.

3.5.2 Connector X2 – (61-120)

Pin No.	Signal	IO Type
61	A1	O
62	A3	O
63	A5	O
64	A7	O
65	A9	O
66	A11	O
67	A13	O
68	A15	O
69	A17	O
70	A19	O
71	$\overline{\text{ABE1}}$/SDQM0	O
72	LED_ACT	O
73	GND	-
74	RX+	I - 49R9 pull up to 2V5
75	RX-	I - 49R9 pull up to 2V5
76	ADRY	I - 10k pull up
77	$\overline{\text{BG}}$	O
78	CLK_out	O
79	GND	PWR
80	$\overline{\text{AMS3}}$	O
81	$\overline{\text{AWE}}$	O
82	$\overline{\text{NMI}}$	I - 10k pull up
83	D0	I/O
84	D2	I/O
85	D4	I/O
86	D6	I/O
87	D8	I/O
88	D10	I/O
89	D12	I/O
90	D14	I/O
91	D15	I/O
92	D13	I/O
93	D11	I/O
94	D9	I/O
95	D7	I/O
96	D5	I/O
97	D3	I/O
98	D1	I/O
99	$\overline{\text{RESET}}$	I – see chapter 3.6
100	$\overline{\text{AOE}}$	O
101	$\overline{\text{ARE}}$	O
102	$\overline{\text{AMS2}}$	O
103	VDD-RTC	PWR
104	$\overline{\text{BGH}}$	O

105	$\overline{BR}$	I - 10k pull up
106	VA25/VA33	PWR
107	TX-	O - 49R9 pull up to 2V5
108	TX+	O - 49R9 pull up to 2V5
109	LED_FD	O
110	LED_SPEED	O
111	$\overline{ABE0}$/SDQM0	O
112	A18	O
113	A16	O
114	A14	O
115	A12	O
116	A10	O
117	A8	O
118	A6	O
119	A4	O
120	A2	O

Table 3-5: Connector X2 pin assignment

Note: Please mind the mounted pull up and pull down resistors on the Core Module. See the third column of Table 3-5.

3.5.3 Pin out Description

All pin names except those in Table 3-6 of the connectors are processor pins and correspond closely to the names found in the Blackfin BF537 datasheet from Analog Devices.

PIN Nr.	Name	IO Type	Description
5,78	CLK_out	O	25MHz buffered clock output
9,10	Vin 3.3V	PWR	3V3 +-10% 500mA peak for supply
35	nc	-	Not connected
72	LED_ACT	O	Indicates Ethernet activity
73	GND	PWR	AGND (use as GND for Ethernet
74	RX+	I	Ethernet receive +
75	RX-	I	Ethernet receive -
106	VA25	PWR	Ethernet transformer voltage reference
107	TX-	O	Ethernet transmit -
108	TX+	O	Ethernet transmit +
109	LED_FD	O	Full duplex LED, High = Full duplex active,
110	LED_SPEED	O	10Mbps = Low, 100Mbps = High

Table 3-6: Pin description of all non Processor Pins on the CM-BF537E

3.6 Reset circuit

The reset of the flash and the processor are connected to a power monitoring IC. The output can be used as power on reset for external devices, see Figure 3-6.

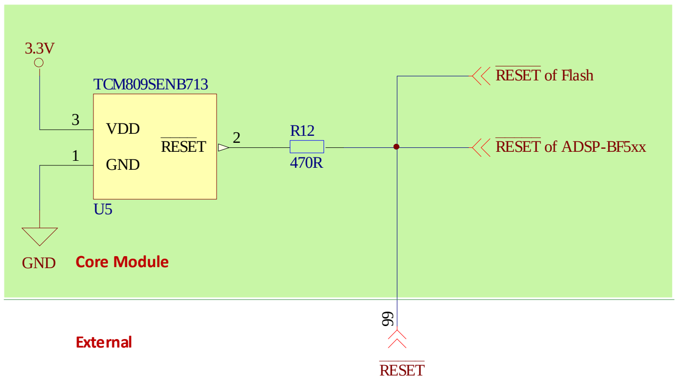


Figure 3-6: Schematic of reset circuit on the Core Module

3.7 RJ45 schematic

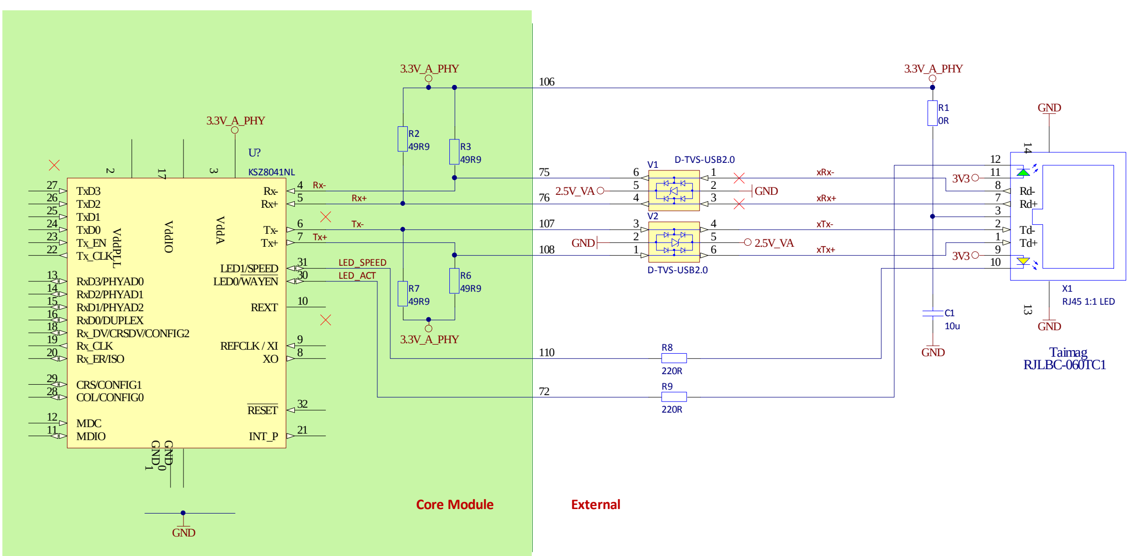


Figure 3-7: Schematic for RJ45 Connection

Designator	Value	Type	Description	Quantity
X1		RJLBC-060TC1	RJ45 with transformer 1:1	1
C1	10uF		Capacitor	1
R8, R9	220R		Resistor	2
V1, V2		USBLC6-2P6	TSV-Diode	2

Table 3-7: Parts List RJ45

4 Test Points

4.1 Footprint – Test Points

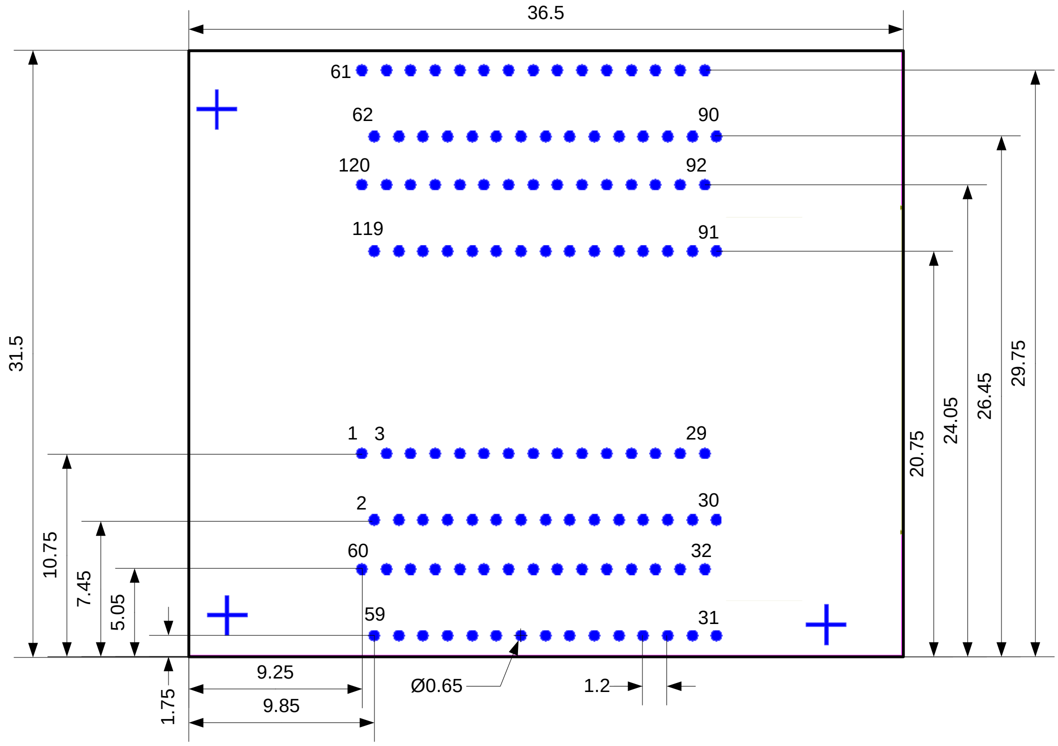


Figure 4-1: Test Points of the Core Module (top view)

5 Software Support

5.1 BLACKSheep

The Core Module is delivered with a pre-flashed basic version of the BLACKSheep VDK multithreaded framework. It contains a boot-loader for flashing the Core Module via the serial port.

By default the BLACKSheep for the CM-BF537E has a web server. By typing http://192.168.0.10 you can see a standard web page installed on the Core Module.

Please consult the software development documents.

5.2 uClinux

The Core Module is fully supported by the open source platform at http://blackfin.uclinux.org. Since the Core Modules are pre-flashed with BLACKSheep you have to flash uBoot first. To flash uBoot you can use the BLACKSheep boot-loader.

6 Application Examples

6.1 Sample Schematic

In this minimum configuration the CM-BF537E is used as a high performance network connected processor module.

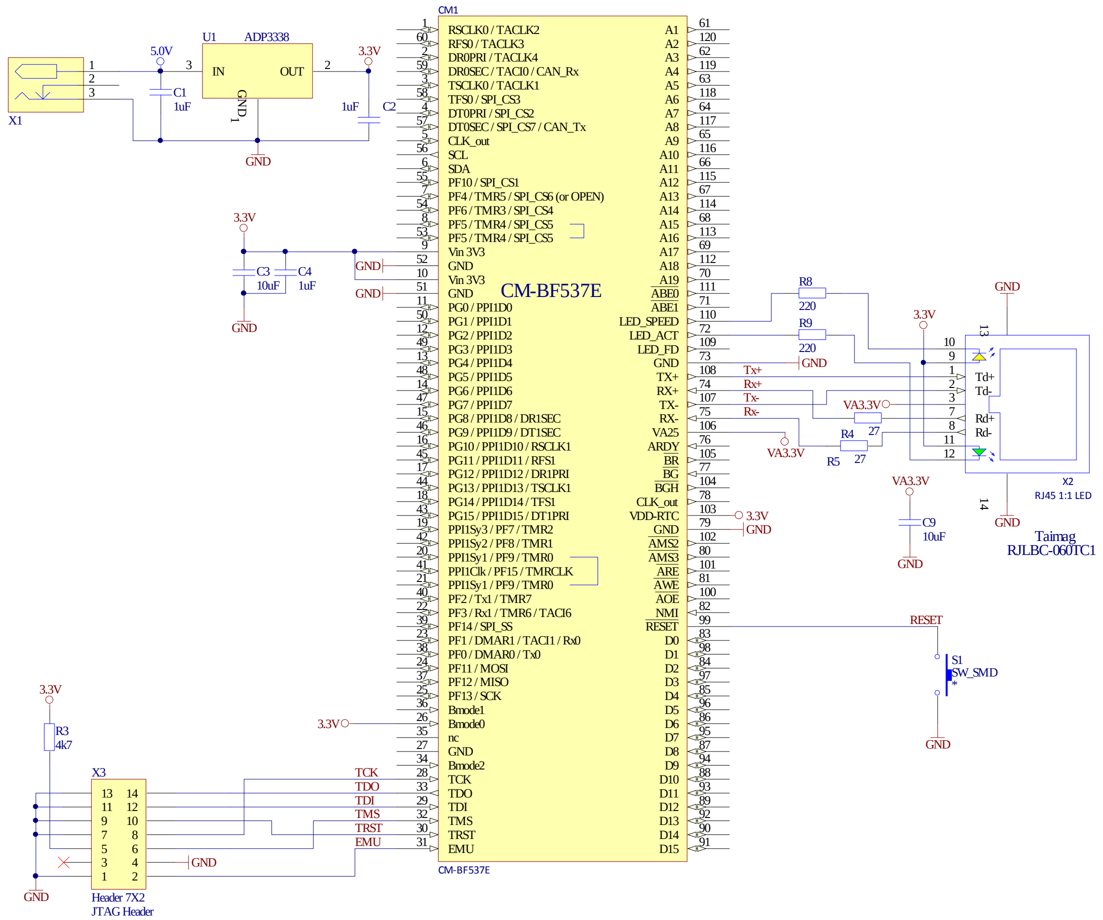


Figure 6-1: Configuration with Ethernet and JTAG Connector

Designator	Value	Type	Description	Quantity
C1, C2, C4	1uF		Capacitor	3
C3, C5	10uF		Capacitor	1
CM1			CM-BF537	1
X1		DC-8	Power connector DC-8	1
X2		RJLBC-060TC1	RJ45 with transformer	1
X3			Header, 7-Pin, dual row	1
R3	4k7		Resistor	1
R8, R9	220R		Resistor	2
S1			Switch	1
U1		ADP3338	Low dropout regulator	1

Table 6-1: Bill of Material of Sample Circuit

6.2 Stand-alone Ethernet based MPEG Webcam

The CM-BF537E module can be used as a stand-alone module for a camera system requiring only power supply and the direct attachment of a compatible video camera. An extender board including a camera is available at Bluetechnix (EXT-BF5xx-Camera).

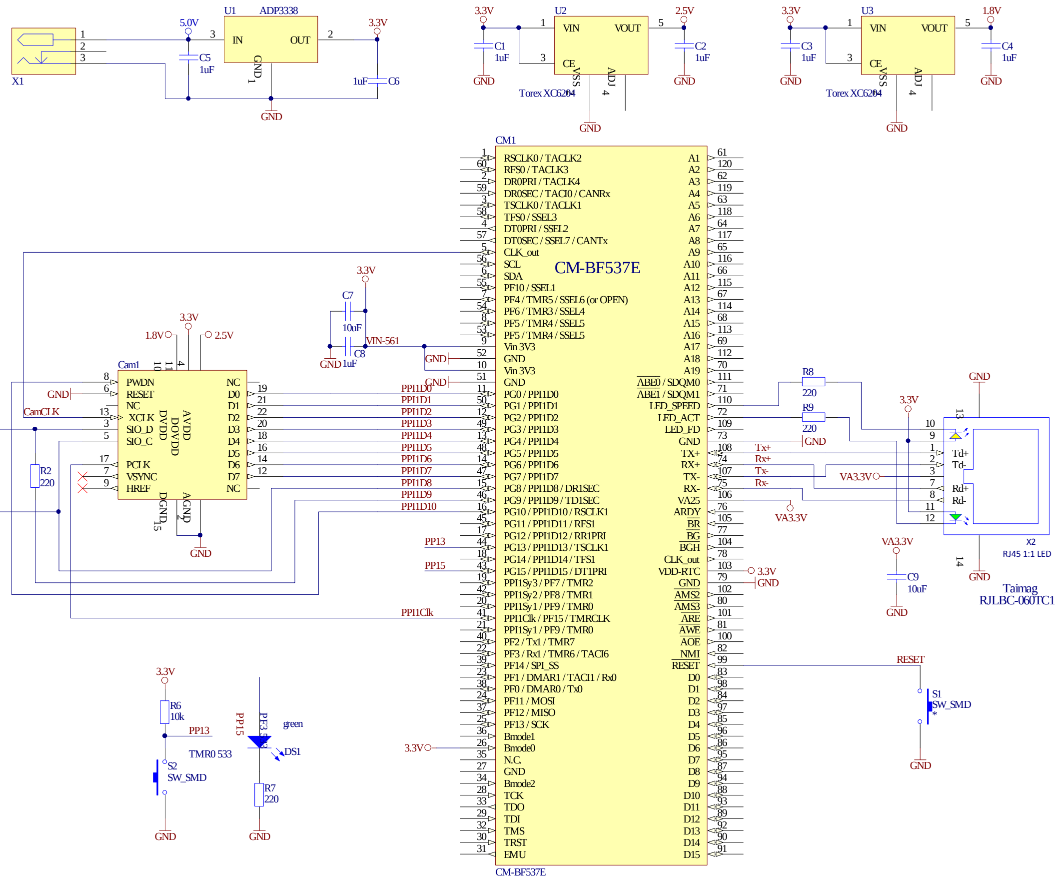


Figure 6-2: Stand-alone Ethernet based MPEG Webcam

Designator	Value	Type	Description	Quantity
C3, C4, C5, C6, C8	1uF		Capacitor	6
C7, C9	10uF		Capacitor	1
Cam1		OV7660FSx	Camera module	1
CM1			CM-BF537	1
DS1	green		SMD LED	1
X1		DC-8	Power connector DC-8	1
X2		HFJ11-2250E	RJ45 with transformer	1
R1,R3	10k		Resistor	3
R7, R8, R9	220R		Resistor	2
S1, S2			Switch	1
U1		ADP3338	Low dropout regulator	1
U2		XC6204B252MR	XC6204 high speed LDO	1
U3		XC6204B182MR	XC6204 high speed LDO	1

Table 6-2: Bill of Materials of a Stand-alone Ethernet based MPEG Webcam

6.3 Design Services

Bluetechnix offers custom design services and software development.

7 Anomalies

For the latest information regarding anomalies for this product, please consult the product home page:

http://www.bluetechnix.com/goto/cm-bf537e

8 Production Report

8.1 CM-BF537E (100-1221)

Version	Component	Type
V3.0.1	Processor	ADSP-BF537 KBCZ-6A (Rev 0.3)
	RAM	MT48LC16M16A2BG-75 IT:D
	FLASH	PF48F2000P0ZBQ0
	Mount Option	MO2 see chapter 3.3

Table 8-1: Production Report CM-BF537E

8.2 CM-BF537E-I (100-1229)

Table 8-2: Production Report CM-BF537E-I

9 Product Changes

For the latest product change information please consult the product web-page at:

http://www.bluetechnix.com/goto/cm-bf537e

10 Document Revision History

Version	Date	Document Revision
2	2009-11-05	Picture 3-7, 6-1, 6-2, Table 6-1, 6-2 updated
1	2009-08-31	First release V1.0 of the document copied from CM-BF537 V1.2 and updated to Revision 3.0

Table 10-1: Revision History

A List of Figures and Tables

Figures

Tables